Passing the Bubble: Cognitive Efficiency of Augmented Video for Collaborative Transfer of Situational Understanding

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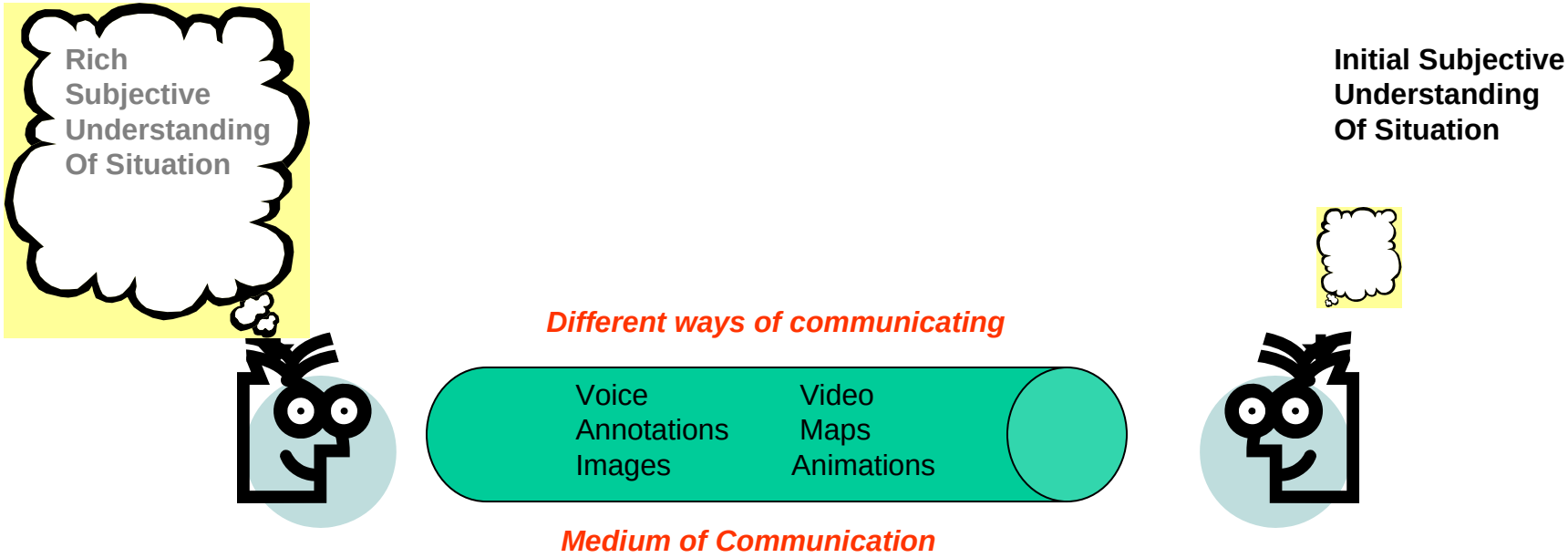
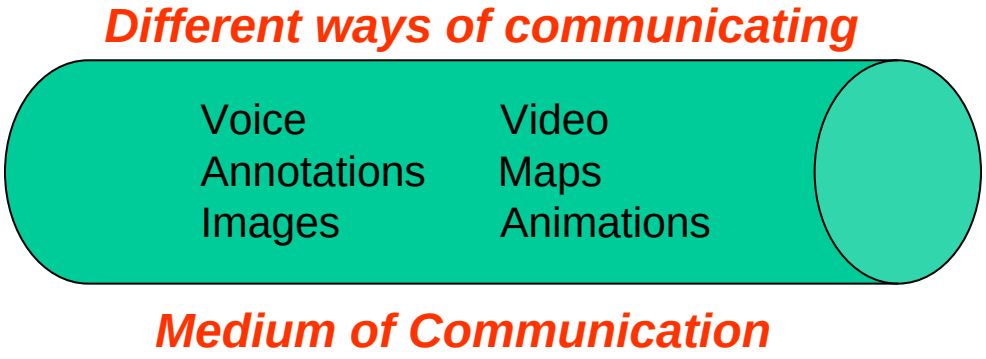
Problem Being Addressed: Passing the Bubble



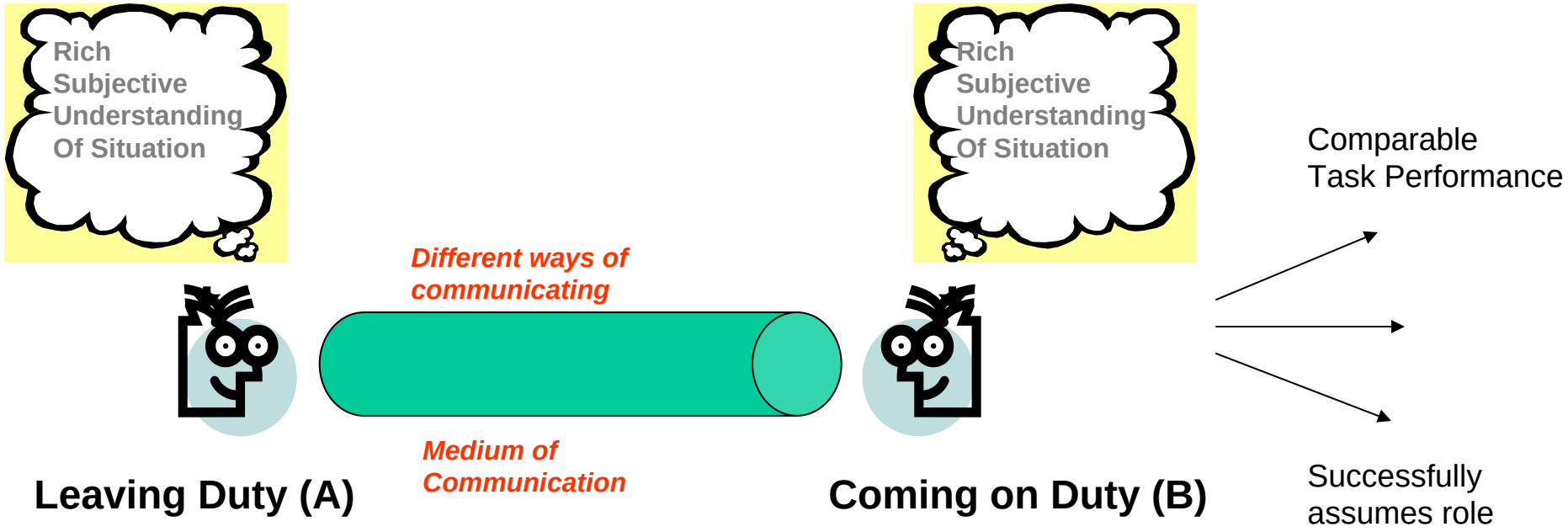
Basic Assumption

Representations vary in how effective they are at facilitating:

- Shared understanding
- Coordination



Successful transfer



Overall Objectives

1. Develop **guidelines**
   - how best to annotate videos and video annotate stills so as to improve shared understanding
   - simulate realistic planning contexts in order to determine how planners and analysts should annotate stills and videos to make better decisions
2. Experimentally discover media factors affecting:
   - **Shared Understanding** – explicit and operational knowledge
   - **Decision-Making** – what information format best helps decision-makers
   - **Video-Augmented Collaboration** – is collaboration improved by using annotation on video as a method of situating problem solving and discussion
3. Deepen Theoretical Framework
   - Distributed Cognition
   - Knowing That vs. Knowing How

This Year's Objectives

1. Develop the technical environment
   - Tools to annotate videos and video annotate stills off-line
   - Tools to collaboratively annotate video signal in real time
2. Discover which factors affect single subjects
   - **Shared Understanding**

     is there a dissociation between explicit and operational knowledge?
   - **Informed Decision-Making** – what information format is best to pass the bubble to a decision-maker

Theoretical Orientation

- Distributed Cognition
  - Cognition is distributed over the interactions between agents, the resources in their environment, tools, cultural constraints in behavior and tool/resource use, effectively designed environments, etc
  - Study problem solving from a D-cog perspective
- Representational Efficiency:
  - How deeply is information assimilated – 1st vs. 3rd person perspectives:
  - 3rd person knowledge: world state, facts and figures
  - 1st person perspective: operational, perspectival:
    - orienting oneself in the spatial layout
    - synchronizing with the timing of actions
    - internalizing player expectations and goal structure …

Long-term Goals

1. Improving collaboration and decision making
   - Guidelines: when should augmented video be used and when is it not worth the extra cost
   - Articles & Theoretical models
     - Extend theory of distributed cognition
     - Coordination Theory
2. Cognitive efficiency of augmented video and other representations
   - Articles & Theoretical models
     - Extend theory of representation to dynamic representations

Definition of Key Terms

- Passing the bubble: communicating situational knowledge, for example when a commander replaces another on watch.
- Augmented Video: video with annotations
- Representational Efficiency: how effective different representational formats are at causing a subject to enter a specific knowledge state
- Attention Management: a method for controlling what an audience focuses on
- Cognitive Load: a measure of how much of a subject's cognitive resources are recruited in a task or activity
- Dynamic Representations: representations that change over time (animations, video, …)

The game: Starcraft

- A logistics and strategy real-time game:
  - Goal: wipe out the enemy!
  - Three interstellar "races": Humans, Protoss and Zerg with different forces and weaknesses, different units, technologies, etc.
  - Strategy: build up military, technology and economy to pay for it.
  - Strategic choices:
    - fortifications versus military units,
    - Small high-tech army versus large low-tech army
    - …
  - Two types of resources must be gathered from different sites on the map, by the relevant industrial buildings and units. Military and technological buildings allow to build forces, used to defeat the enemy.
- Video intro to Starcraft: 50 sec, 4 min, 4.5 min

- Strategic expertise: takes 500 to 1000 hours to achieve
- Game duration: about 40 minutes

Problem Being Addressed: Specific Task Domain

The role of augmented video in passing the bubble:

- Which types of augmented video cause cognitive overload
- Is augmented video always better than well-chosen stills?
- Can we dissociate communicating context from communicating intent (what the situation is from what we want the situation to be, and the means to get there)?

Our Current Testbed

- Simplified environment: a strategy game
- The bubble is passed by different representation types
- Several measures of cognitive efficiency:
  - Explicit knowledge gained (third person, “knowing *that*”) – from questionnaire (“what units is my enemy using”)
  - Task performance (Win/Lose, time to completion, Game Score increment in first 5 minutes)
  - Subjective judgement – questionnaire (overall preference, how informative, “how confident do you feel you know what’s going on”)

Experimental Design

- Within subject design (each subject tries all the stimuli, and is analyzed independently)
- There are 9 types of presentations, with variations in the type of annotation and the type of background that bears the annotations
- For each type we plan 10 stimuli
- Every time, the subject:
  - Attends the presentation
  - Is tested by a questionnaire, to know what has been learned explicitly,
  - Resumes the game, against the original enemy player
- Implicit and context understanding is tested by how well the subject does in the resumed game.

Technical Approach

Types of Stimuli

	Random Stills/Control	Chosen Stills	Video
No Annotation	Random Stills, Voice No Annotations	Chosen Stills, Voice No Annotations	Video, Voice No Annotations
Static Annotation	Random Stills, Voice Static Annotations	Chosen Stills, Voice Static Annotations	Video, Voice Static Annotations
Dynamic Annotation	Random Stills, Voice Dynamic Annotations	Chosen Stills, Voice Dynamic Annotations	Video, Voice Dynamic Annotations

Stimulus Demo

SELECTED STILLS,
NO ANNOTATION

(if it is not playing after 4 seconds, double-click here to start presentation in media player)

Current Progress

- Start date: April 2002
- Experimental progress
    - 70 Stimuli prepared
    - 46 stimuli ran on 2 subjects
- Technical Progress
    - Constructed annotation environment, with an option for collaborative annotation

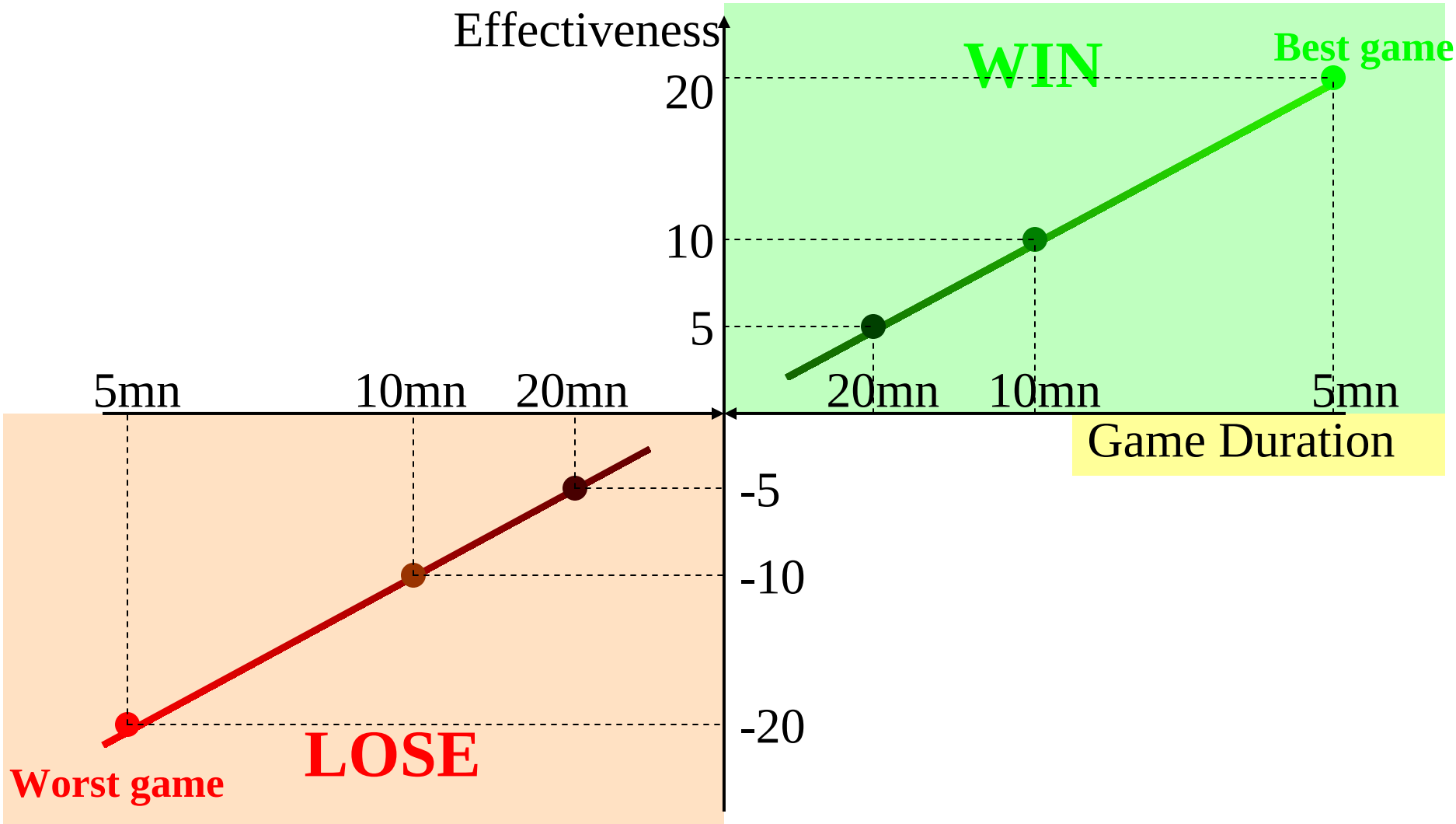
Experimental Milestones FY 2003

1.	Video Annotation Environment	100% complete
2.	Creation of Experimental Stimuli	70% complete
3.	Subjects attend the Stimuli and resume the game	25% complete
4.	Collaborative Annotation Environment	60% complete

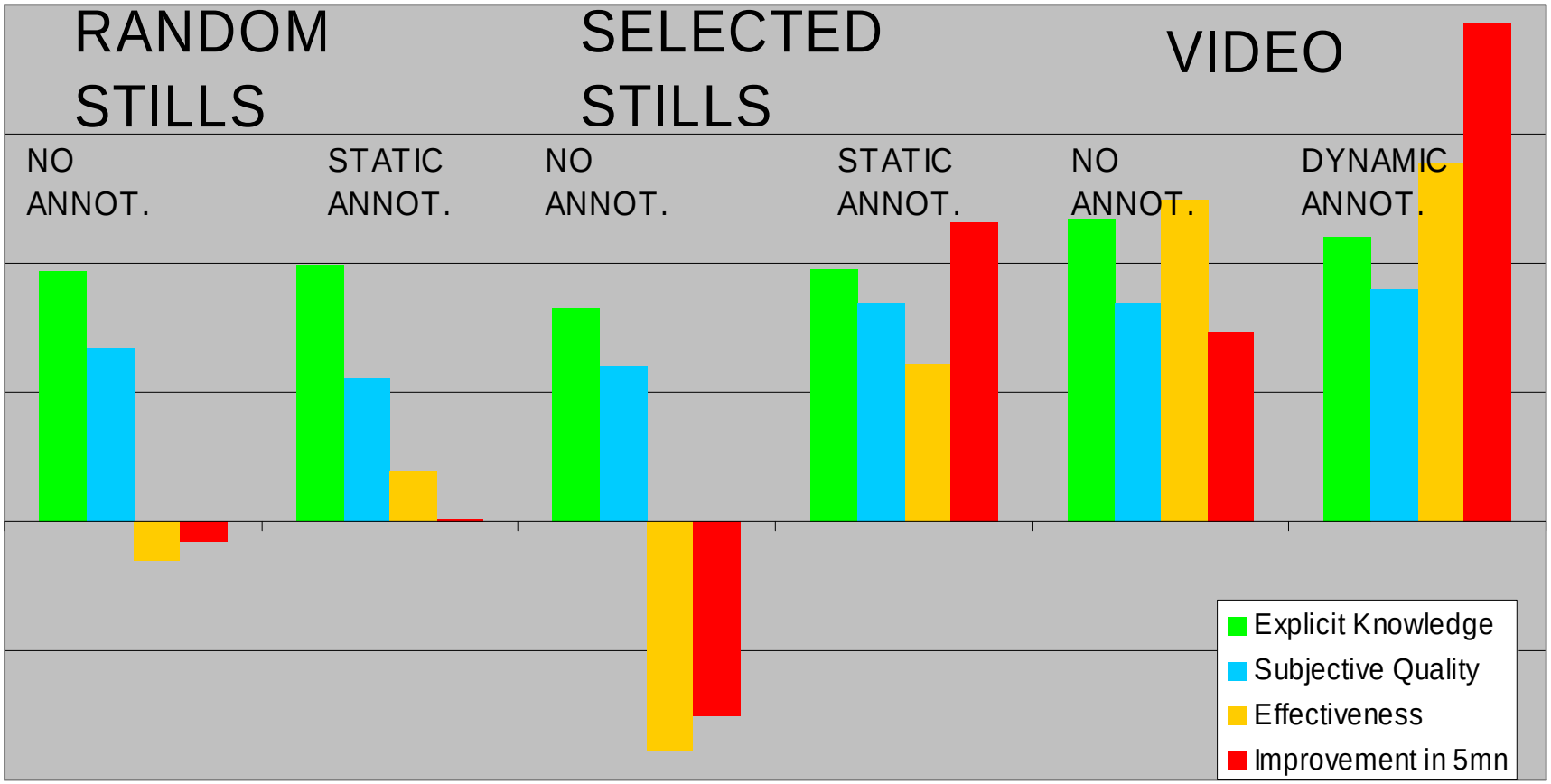
Results – Metrics

- Explicit knowledge
  (twelve questions about items in the presentation)
- Subjective Quality of Stimulus
  (overall rating, how confident, how informative)
- Effectiveness
  (gain/loss)*(1/ time to completion)
- Improvement in 5 minutes
  (gain in percentage of total score in the first five minutes)

What is “effectiveness”?



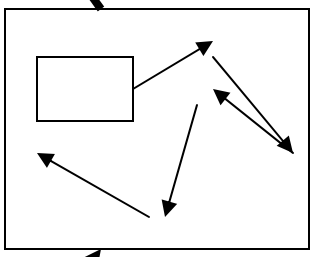
Initial Results (26%, Dec.22,2002)



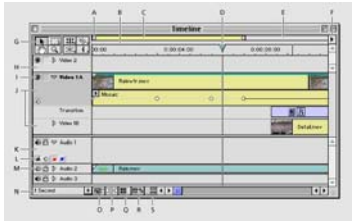
Video Annotation Chain

Build Narrative:

Replay



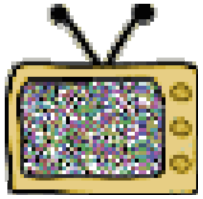
Viewpoints



Capture and prune

Slow down

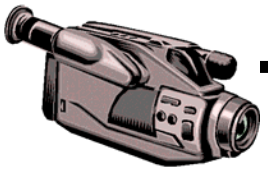
Annotate:



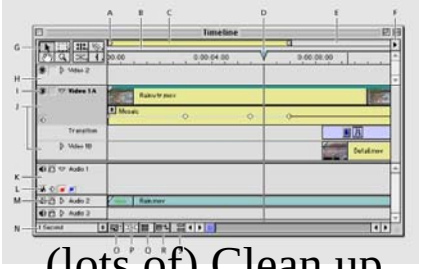
Digital to analog

Pointmaker-Annotate

record



Re-capture



(lots of) Clean up

Back to tempo

Add Commentary

Recommendations / Lessons learned

- Tools:
  - Capture, basic production, annotation of stills (including dynamic annotations): Camtasia
  - Dynamic annotation of video, off-line: Premiere + AfterEffects + Vector Paint
  - Dynamic annotation of video, on-line: Pointmaker
- Experimental Protocol: record everything! (for example, subjects talk about their games afterwards, revealing the structure of their beliefs about the game, how it induced bright moves or mistakes, and how it changed during the game)

Planned Publications

- Article on The Representational Efficiency of Augmented Video and Dynamic Representations
- Article on Augmented Collaboration: using Augmented Video as a Method of Situating Problem Solving

Research Team

Team

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Research Team